Investigating the Photophysical and Photochemical Mechanism of a Novel Sensitizer Pd- Bacteriopheophorbide by using ESR and Spin trapping Technique

Y. Vakrat*, L. Weiner* A. Brandis*, Y. Salomon*, and A. Scherz*, A. Pawlak[#], M. Roanowska[#], M. Wrona and T. Sarna[#], B. Wilson[!] and B.McIlroy[!]

* Weizmann institute of Science, [#] Institute of Molecular Biology, Jagiellonian University, Krakow, Poland, [!] Princess Margaret Hospital, Toronto, Canada

Photodynamic therapy (PDT) is based on selective damage to phatologically modified cells and tissue, induced by photosensitized oxidation reactions. Bacteriochlorophyll (Bchl) derivatives with substituted Mg and peripheral groups comprise a novel family of photosensitizers. Substitution of the Mg by a palladium atom provides a relatively photostable and pure compound with strong absorption at 760nm (extinction coefficient of $10E^{+5}$ $mole^{-1}$ cm^{-1} in Chloroform). The derivative Pd-bacteriopheophorbide (Pd-Bpheid) (under the code name TOOKAD) was found to be very efficient in vitro and in vivo.
The formation of .OH and $O2^{\bullet -}$ with a significant quantum yield by a concomitant abstraction of two hydrogen and two electrons from the excited sensitizer in Triton X-100/PBS could be identified only by ESR and the spin trap DMPO. The formation of .OH radicals was further supported by photochemical product analysis. The formation of 1O2 was demonstrated by using the spin trap TEMP and further quantified various techniques. Comparison of kinetic rates for the formation of the DMPO-OH adduct, $TEMPO^{\bullet}$ radical, and enhancement of the signal DMPO-OH in the presence of NaN3, eliminated the possibility that DMPO-OH adduct formation is resulted from DMPO-oxidation with other species than $^{\bullet}OH$ radicals.
Time-resolved singlet oxygen phosphorescence showed a quantum yield of >99% for singlet oxygen formation in organic solvents which drops down to ~60% in membrane-like systems (micelles or liposomes), suggesting that the type of generated ROS depends on the microenvironment of the excited TOOKAD.